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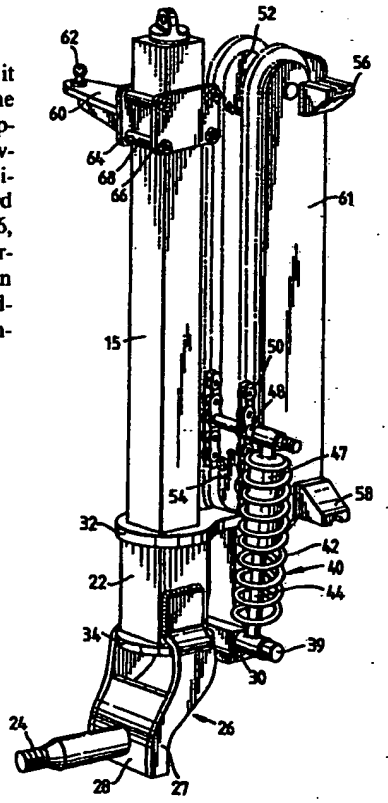
(54) Title: VEHICLE WITH RETRACTABLE WHEEL

(57) Abstract

A vehicle has a wheel (10) which is movable between a lower position in which it can be used, and a raised position for storage, by a wheel retraction mechanism (14). The retraction mechanism comprises a support element (48) connected to the wheel via a coupling on the element and includes a rotary member movable by a chain (50) drive for moving the element in a path encompassing a highest position of the coupling, a lowest position of the coupling, a downward return beyond the highest position and an upward return beyond the lowest position. The mechanism includes respective abutment stops (56, 58) disposed in the path of the element on the downward and upward returns to block further movement of the element with the coupling over-centred. This supports the wheel in both the raised and lowered positions against the prevailing forces on the element. An additional independent locking system for the extreme positions of the retraction mechanism is also disclosed.



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VEHICLE WITH RETRACTABLE WHEEL

The present invention relates to vehicles with retractable wheels, particularly, but not exclusively, suitable for use in amphibious craft. In particular the invention concerns the supporting of the wheel position while the wheel is in use.

There are many different disclosures of amphibious craft but in most cases the wheels are moveable between a lower position in which they engage the ground and via which the craft is driven on land, and a raised position in which they are stored while they are not in use. In order to reach the required current levels of safety it is necessary to support the wheels in at least the lower position. In most disclosures the wheels are held in the lower position by the retraction mechanism which raises and lowers the wheels, for example a hydraulic ram. This does not provide adequate safety as it does not cater for ram failure. In the upper position the wheels are also held and firmly supported by the retraction mechanism.

It is the object of the invention primarily to provide a safety stop for the wheel mechanism to support the wheels, particularly in the lower position when carrying the vehicle weight.

According to the present invention there is provided a vehicle having a wheel which is moveable between a lower position and a raised position by a wheel retraction mechanism, characterised in that the retraction mechanism comprises a support element connected to the wheel via a coupling on the element and means for moving the said element in a path encompassing a highest position of the coupling, a lowest position of the coupling, and an upward return beyond the said lowest position; the means for moving the element comprising a rotary member and the mechanism including

an abutment disposed in the path of the element to limit the upward return of the element.

The support element may be an arm which is swung by the rotary member so that the said highest and lowest positions of the coupling are on a vertical plane taken through the axis of the rotary member. The rotary member may be directly driven from a motor, or may be turned indirectly by a transmission such as a chain, band or rope. Alternatively the support element may be a bar or rod which is carried on an elliptical path by a transmission such as a chain, band or rope. The transmission may be continuous. Alternatively the tranmission may have fixed ends and means is provided to transmit the rotary movement by action on the transmission between the ends. It is preferred that the rotary member is driven by a transmission rather than directly because it overcomes the problem of reliance on particular sprocket or gear teeth and thus wear of those teeth.

Where the transmission is continuous, the rotary member may be a sprocket or truckle for example. In both cases the support element is advantageously connected to the wheel via a suspension device or shock absorber.

Advantageously the wheel is also stopped in the raised position by an abutment disposed in the path of the support element to limit the down return of the element past the highest position of the coupling.

By overcentering the support element at upper and lower positions the wheel is held in position by the prevailing forces on the support element, thus removing the necessity for other locking mechanisms, although a lock or latch can also be used if desired, for example actuated by the retraction mechanism motor.

A guide may be provided to determine the path of the wheel during retraction in response to movement of the support element.

Advantageously the element comprises at least one crank arm which is rotatable about an axis between upper and lower extreme pivotal positions defined by respective abutments, the said coupling being spaced from the said axis and the total angle of movement of the arm between the extreme positions being greater than 180 degrees.

Preferably a subsidiary locking arrangement is provided for the retractable wheel mechanism, the locking arrangement comprising a locking bar pivotally connected at one end to the crank arm to pivot with respect to the arm, and pivotally mounted via a support at the other end, the arrangement including means allowing for the change in distance between the said one end of the locking bar and the said support as the crank arm pivots, and means operable to lock the locking bar when the crank arm is in an extreme pivotal position.

Advantageously the locking bar is pivotally mounted via a support to pivot, and to slide on a first path, as the arm pivots; wherein the means operable to prevent the said one end of the locking bar from moving includes a locking member which is moveable in a second path intersecting the first path; wherein the operation includes the transfer of the locking member to block the first path to prevent sliding movement of the locking bar. Alternatively the locking bar may be telescopic and the means operable to lock the locking bar would lock either the extension or the angle for example.

The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 shows the outline of the front part of an amphibious craft cut away to illustrate in perspective a wheel support and retraction mechanism according to one embodiment of the present invention,

Figure 2 shows the wheel mechanism of Figure 1 in greater detail,

Figure 3 is a detailed view of part of the wheel retraction mechanism of Figure 1,

Figure 4 is an expanded view of the collar and collar-carrier of the retraction mechanism of Figure 1,

Figure 5 illustrates a driven-wheel retraction mechanism for an amphibious craft according to a second embodiment and having an independent locking mechanism, which may be used for example for the rear wheels of the craft of Figure 1,

Figure 6 is a side view of part of the mechanism of Figure 5,

Figure 7 is a part plan-view of an embodiment similar to that of Figure 5,

Figure 8 is a side view of a further embodiment of the wheel retraction locking mechanism, with one crank arm shown in plan at Figure 8a, and

Figure 9 shows details of the independent, subsidiary locking mechanism for the retraction mechanism of Figure 5,

Figure 1 illustrates a steered forward wheel 10 of a medium speed amphibious craft which wheel is retractable into a compartment 11 in the craft. The wheel is supported by a wheel support mechanism 12 and is raised into the compartment for storage and lowered for road use by means of a retraction mechanism 14.

As will be seen in Figure 1 and 2, the wheel support mechanism includes a pillar 15 which is pivotally mounted at the upper end to the craft. In this case the pillar is mounted via a pivot 16 to a bracket 18 fixed to the inner wall 20 of the compartment. In this particular craft the inner wall of the compartment is part of the hull stress-bearing structure. The lower end of the pillar 15 is also pivotally mounted via a

similar hinge pivot and bracket (not shown). A collar 22 is fitted on the pillar 15 to be slidable up and down the pillar and rotatable with the pillar. In this case the section of the pillar and that of the collar are both square. However the shape is not important so long as the sections cooperate to prevent relative rotation between the pillar and the collar.

The wheel 10 is fitted on a threaded stub-axle 24 which is coupled to the collar 22 via an arm 26 which holds the stub-axle 24 out from the bottom of the collar. The arm 26 is a double bracket construction with a respective bracket 27 welded to each side of the collar and the pin 24 is fitted into an infill piece 28. Any suitable fabricated structure or casting designed to support the stub axle would be adequate as the arm 26 to replace the brackets 27, for example a box-section. The collar 22 is moved up and down the pillar 15 by a collar carrier 30.

The collar carrier 30 (see Figure 4) comprises upper and lower ring brackets 32 and 34 joined at one end by a connector bracket 36. A bar 38 is fitted at the junction between the connector bracket 36 and the lower ring bracket 34, the bar 38 incorporating a rod 39 protruding from each side. The lower end of a suspension device 40 is pivotally fitted on each end of the rod 39.

Figure 4 illustrates the assembly of the collar 22 and collar carrier 30, which takes place before the assembly is fitted to the pillar 15. The top of the collar comprises a threaded ring 41. The collar carrier 30 is located with its ring brackets 32,34 one above and one below the collar 22 and is held in position by a first threaded cap 43 which passes through the upper ring bracket 32 to screw into the threads of the ring 41 and a second threaded cap (not shown) which passes through the lower ring bracket 34 upwardly to screw into the bottom of the collar. The inner bore of the caps 43

each have a square section to fit over the pillar 15. The fitting of the collar and collar carrier incorporates anti-friction surfaces or devices between the ring bracket 32 and the collar surface 41 and between the lower ring bracket 34 and the threaded cap (not shown). Suitable anti-friction devices include anti-thrust races, or nylon bushes, or the ball race 45 shown. The wheel can be steered by means of a steering arm bracket 60 (Figure 2) carrying a ball 62 and fitted to the pillar 15 by a plate 64 and four sets of nuts 66, bolts (not seen) and spacers 68 which are welded to the pillar. Movement of the steering arm bracket 60 by means of the ball 62 causes rotation of the pillar about the pivotal mountings. The collar 22 turns with the pillar 15 carrying the wheel with it. This action is described in patent specification GB 2,218,052. The collar carrier 30 allows the pillar 15 to turn within it on thrust races such as the ball race 45.

Each suspension device or shock absorber 40 comprises a compression spring 42 fitted around a piston 44 and damper 47 in the usual way. The upper end of the two suspension devices 40 are both hinged to a support element comprising a rod 48 mounted on and fixed to travel with a double chain 50. The rod 48 is fitted to the double chain 50 to be moveable with the chain.

The double chain 50 is a strong continuous chain mounted about two pairs of rotary members in the form of sprockets 52,54. The sprockets forming each of the sprocket pairs 52,54 are locked together on a respective common shaft 55,53 to maintain parallel motion of the chains to prevent tilting of the rod 48. The shafts 55,53, are supported for rotation on a frame 61. In this case the shafts 53,55 forming the axes of the sprockets are mounted vertically one above the other, but this is not thought to be critical. In fact if a castor or camber angle is required the axes may be deliberately

set not vertically one above the other to create, for example, a 2 1/2 degree angle between the vertical and the chains. The pillar 15 would have to be set at a corresponding angle.

To raise or lower the wheels 10, one pair of the sprockets 53,55 is driven either clockwise or anticlockwise by an electrical motor (not shown) causing the rod 48 to move up or down in a path determined by the movement of the chains 50 and the position of the sprockets 53,55. This in turn lifts or lowers the suspension devices 40 and thus the wheel 10 and in so doing causes the collar carrier to move on the pillar 15. The locking of the wheels is achieved in two ways - firstly the electric motor (not shown) operates through a gear box with final drive by worm and wheel which in certain circumstances can prevent movement of the chain when the motor is not powered. Secondly, when the rod 48 passes either its highest or lowest point of its path and begins the return path it comes up against upper or lower abutment blocks 56,58 which are fitted to the frame 61 in the path of the rod 48 and which arrest the rod. The upper blocks 56 are fitted on the return for the upward travel, far enough beyond the highest position of the rod 48 so that when the rod is abutted against the block the weight of the wheel is taken on the block 56 rather than on the chains 50 or sprocket teeth 53,55. The blocks 56,58 are shown schematically in the drawings. In practice they need to be shaped so that the rod is supported on each side of the suspension unit mountings to permit the two suspension devices 40 to hang and swing freely therebetween. The lower blocks 58 are fitted on the return from the downward travel, far enough beyond the lowest position of the rod 48 for the upward reaction force from the road on the wheel to be taken on the blocks 58 rather than on the chains 50 or sprocket teeth. In both locked overcentred positions

the chains 50 will hold the rods 48 firmly against the blocks, but they will not take the greater part of the force.

The way that the rotary member is turned is of some importance if both upper and lower locking is required because the rotary member has to turn through more than 180°. This cannot be achieved for example if the rotary member is turned by the direct operation of a ram.

Although the primary advantage of this embodiment is the simple automatic locking system which requires no mechanical or electrical operation by the driver, there is subsidiary advantage in that significant variations in the amount of lift that can be made are achieved by simply lengthening or shortening the frame 61 (Figure 3) and the distance between the sprockets 52 and 54. Furthermore the load bearing capability of the mechanism can be varied by increasing or decreasing the strength of the components. No redesign is necessary. This means that the same principle can be used for any hull, whether it be a shallow hull, or a cathedral, dory of deep-V section hull, even where the required wheel lift is in excess of 2'6". The same principle can be used to lift a pair of wheels and both forward and rear wheels. Moreover the arrangement can be adapted to cater for driven wheels as is described hereafter.

The above wheel retraction mechanism has been illustrated and described in relation to front wheels which are steered. The mechanism is equally suitable if there is no steering or for use to raise and lower a rear wheel.

In an amphibious craft having the wheel retraction mechanism of Figure 5, for example for a rear wheel, the wheel (not shown) is fitted on the bolts 71 and driven by means of a chain drive or shaft (not shown) in casing 72. Details of the transmission can be found by referring to our Patent specification GB 2,219,555A. The

chain casing 72 is pivoted at its upper end to a bracket 73 about a pivot 74 and the bracket 73 is fitted to the inside of an enclosed wheel compartment (not shown) being part of the hull stress bearing structure. The wheel compartment is open only at the bottom, and is disposed inside the mono-coque hull of the craft. The bracket 73 has two parallel sides 75 forming a channel therebetween.

The wheel is raised and lowered by a retraction mechanism 70 comprising a driven rigid crankshaft pivoting on two bearings 85 supported by bracket sides 75, a pair of crank arms 84 driven by the crankshaft, and a pintle 81 rigidly mounted between the crank arms 84 and firmly locked to them to form the crankshaft. The retraction mechanism is connected to the casing via a suspension system 76 pivotally mounted to the pintle 81 and comprising a spring 77 fitted outside a damper 78 and a secondary spring 79. At the upper end the spring 77 abuts a spring housing 80, which spring housing incorporates an aperture allowing a secondary spring and damper mounting 83 to protrude, enabling both the housing 80 and the mounting 83 to pivot on the pintle 81. The spring housing 80 is pivoted to the pintle 81 by means of two mounting brackets 82 attached to the upper end of the spring housing 80. The crank arms 84 form the "support element" of the claims.

The crankshaft is fixed to a rotary member in the form of a sprocket 87 and driven from an electric motor 89 via sprocket 88 and a drive chain 86 . The crank arms 84 are rotated through an arc defined by abutment stops 90,91 (described hereafter) by rotation of the shaft. Movement of the chain 76 turns one arm 84 via the sprocket 77, and the second arm follows. The pivotal arc of the crank arms 84, shown in Figure 6, is from a lower, hatched position against a stop block 90, through a lowest position, through the bracket channel between

the sides 75, through a highest position, and after a downward return, to an upper stop block 91. As the support element 84 rotates between the limiting stop blocks 90,91 (Figure 6), the chain casing 72 and wheel are raised or lowered via the suspension system 76. When the wheel is overcentred in its lowered position, (the support element shown hatched in Figure 6), the upward force is shared by the stop block 90 and the pivot bearings 85. When the support element is rotated to its upper position, it is again overcentred against the stop block 91. In this position any downward loads are shared by the block 91 and the pivot bearings 85, rather than loading the chain or motor. The angle of rotation of the crank arm between stop blocks is more than 180 degrees.

A rectangular or square-section locking element or bar 94 has a yoke 95 the elements of which are pivoted to the pintle 81 between the spring mounting brackets 82 and the webs of the crank arms 84. A roller 96 (Figure 8) is fitted to the free end of the bar 94. Either integral with the bracket 73, or separately adjacent the bracket 73 there is a substantially vertical passage 97 formed by a rectangular or square section tube 98 in which slides a locking block 99, operable from the cockpit via a link 101. The link 101 (Figure 9) may be operated from the cock-pit via a lever system including rods, pivots and/or cables. The passage 97 has a through opening 102 at a position substantially in a horizontal line with the shaft bearings 85 and the single end of the locking bar is supported by a sleeve in the form of a a pivoting sliding trunnion 103 hinged to pivot on pins 104. As the crank arms rotate, the bar 94 slides through the rectangular-section trunnion 103 and through the opening 102 in the tube 98 to cross the passage 97. The tube 98 is fitted to the bulkhead of the craft by means of brackets 105 which support the trunnion 103 at the pins 104. The locking block 99 (Figure 9) comprises

a wedge-shaped body 107 which can roll or slide in the tube 98 via two pairs of small wheels or rollers 108 disposed in respective recesses 109. The body is essentially of the same section as the tube 98 but with its leading and trailing edges curved. At the upper end the locking block 99 is pivoted to the operating link 101 via a through bore 111.

When the crank arms 84 are in either extreme position, i.e. against a block 90,91, then the locking bar 94 is at its outermost position leaving the passage 97 free for the lock to pass to the bottom of the tube 98 behind the bar. In this position the locking bar 94 is prevented from passing through the passage 97 as the roller 107 at the rear end of the bar engages the locking block 99. The position of the locking bar is then fixed until the locking block 99 is withdrawn. Thus the work of the stop block 90,91 is reinforced by the locking bar 94. To release the locking bar, when the wheel is to be moved, the sliding lock 99 is raised by an upward force on the link 101, which pulls the lock 99 out of the path of the locking bar 94 and thus leaves the locking bar free to move through the passage 97 and thus enabling the crank arms 84 to turn. When the arms 84 have reached their other extreme position the locking bar is once again outside the opening and out of the passage and the sliding block 99 may again be lowered to lock the wheel position. The path of the roller 96 as the cank arms turn is shown in Figure 8 at "B". The location and positioning of the safety lock mechanism is important. A line "A" is defined by the longitudinal centre line of the bar 94 when the roller 96 is at its furthest distance from the tube 98. The locking tube 98 is mounted substantially at right angles to the line "A". The geometry of the locking bar and crank arms is such that the shortest line joining the axis of the bearings 85 to the axis of the roller 96 is also line

"A". This line not only joins the central crank shaft pivot 85 to the centre of the opening 102 but it also equally divides the angle of movement θ between the upper and lower positions of the locking bar longitudinal axis.

Although the primary locks are described above as blocks 90,91 which the arms engage, in a second embodiment shown in Figure 8 the bracket sides are shaped with two abutment surfaces 112 and the crank arms have rear extensions 113 each of which carries a stop block 114 which engages with the relevant abutment surfaces 112.

The bracket sides can be boxed in to provide extra strength where appropriate, and suggested areas are illustrated at 116 and 117.

In one embodiment (not illustrated), the roller 96 has its axis guided at each end in a respective slot so that the position of the roller axis changes (as the bar 94 moves between its extreme positions) from one end of the slot to the other. When the bar 84 is on line "A" the roller axis is also on line "A".

It will be appreciated that the additional security of the independent locking facility will provide a further safety feature for the amphibious craft. Tertiary locks may be additionally provided if required.

CLAIMS

1. A vehicle having a wheel which is moveable between a lower position and a raised position by a wheel retraction mechanism, characterised in that the retraction mechanism comprises a support element connected to the wheel via a coupling on the element and means for moving the said element in a path encompassing a highest position of the coupling, a lowest position of the coupling, and an upward return beyond the said lowest position; the means for moving the element comprising a rotary member and the mechanism including an abutment disposed in the path of the element to limit the upward return of the element.

2. A vehicle according to claim 1 wherein the said path includes a downward return beyond the said highest position and the retraction mechanism includes an abutment disposed in the path of the support element to limit the down return of the element past the highest position of the coupling.

3. A vehicle according to any of the preceding claims wherein the support element is connected to the wheel via a suspension device or shock absorber.

4. A vehicle according to any of the preceding claims wherein the rotary member is driven via a transmission.

5. A vehicle according to claim 4 wherein the rotary member is a wheel in the form of a sprocket or truckle.

6. A vehicle according to claim 4 or 5 wherein the transmission is in the form of chain means.

7. A vehicle according to any of claims 4,5, or 6 wherein the transmission is a conveyor driven over upper and lower sprocket or truckle wheels and the said element is a member mounted on the conveyor, the abutment or abutments being located adjacent the conveyor in the path of the member to stop the member in an over-centred position.

8. A vehicle according to any of the preceding claims including a guide fitted to determine the path of the wheel during retraction in response to movement of the support element.

9. A vehicle according to claim 8 wherein the said guide is a pillar, the wheel being attached to a collar which is slidable along the pillar and the collar being connected to the said element optionally via a suspension device or damper unit.

10. A vehicle according to any of claims 4 to 6 wherein the element comprises at least one crank arm which is rotatable about an axis between upper and lower extreme pivotal positions defined by respective abutments, the said coupling being spaced from the said axis and the total angle of movement of the arm between the extreme positions being greater than 180 degrees.

11. A vehicle according to claim 10 characterised by a subsidiary locking arrangement for the retractable wheel mechanism, wherein the locking arrangement comprises a locking bar pivotally connected at one end to the crank arm to pivot with respect to the arm, and pivotally mounted via a support at the other end, the arrangement including means allowing for the change in distance between the said one end of the locking bar and the said support as the crank arm pivots, and means operable to

lock the locking bar when the crank arm is in an extreme pivotal position.

12. A vehicle according to claim 11 wherein the locking bar is mounted via the said support to pivot, and to slide on a first path, as the crank arm pivots; wherein the means operable to prevent the said one end of the locking bar from moving includes a locking member which is moveable in a second path intersecting the first path; wherein a locking operation includes the transfer of the locking member on the second path to block the first path to prevent sliding movement of the locking bar across the first path and thus to prevent movement of the crank arm and wheel.

13. A vehicle according to claim 12 wherein the locking member is supported and guided on a track, or slidable within a passage, which intersects the said first path of the locking bar.

14. A vehicle according to any of claims 11 to 13 wherein the locking member is at least partially tapered or wedge-shaped.

FIG. 1

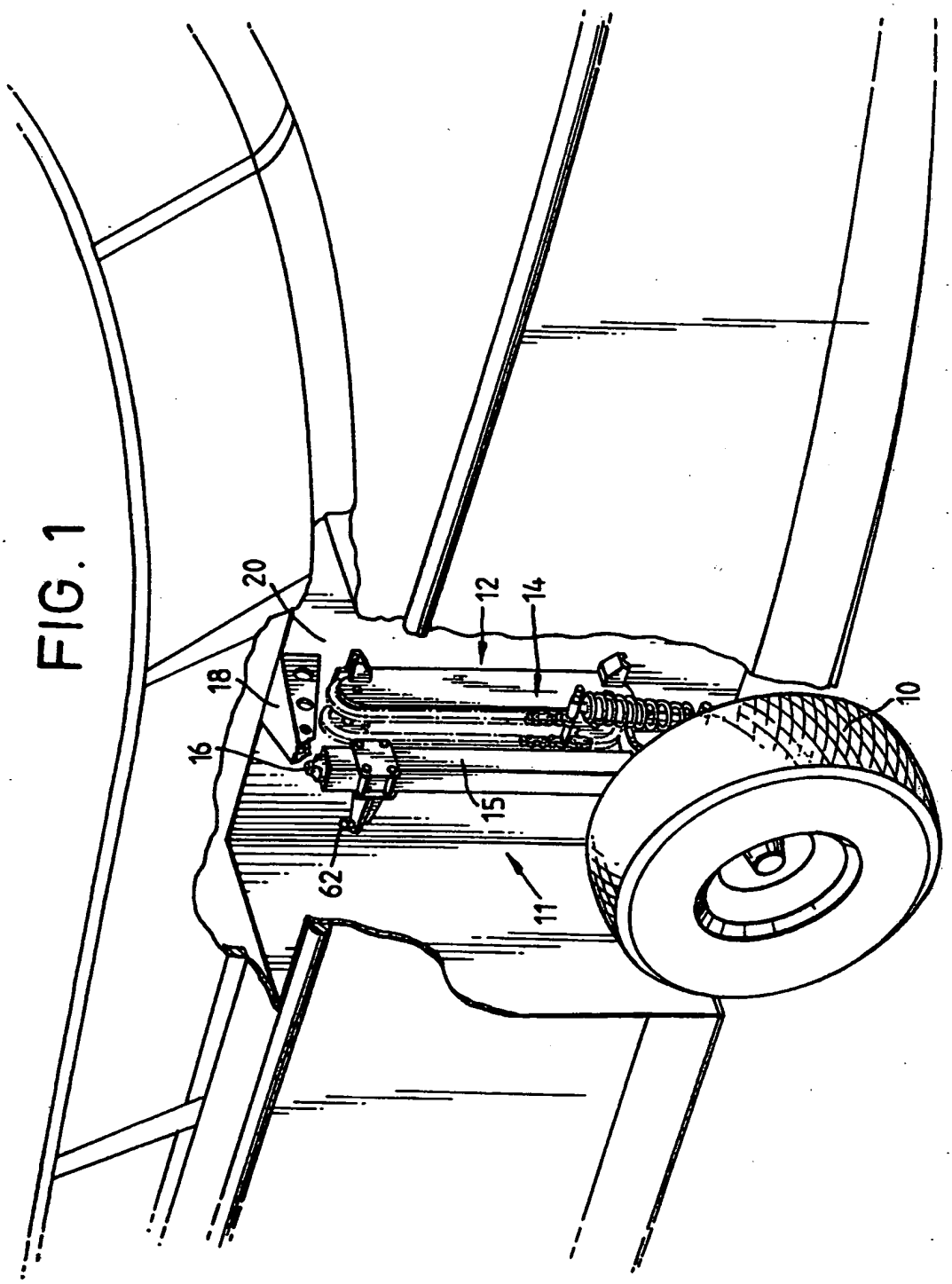

FIG. 2

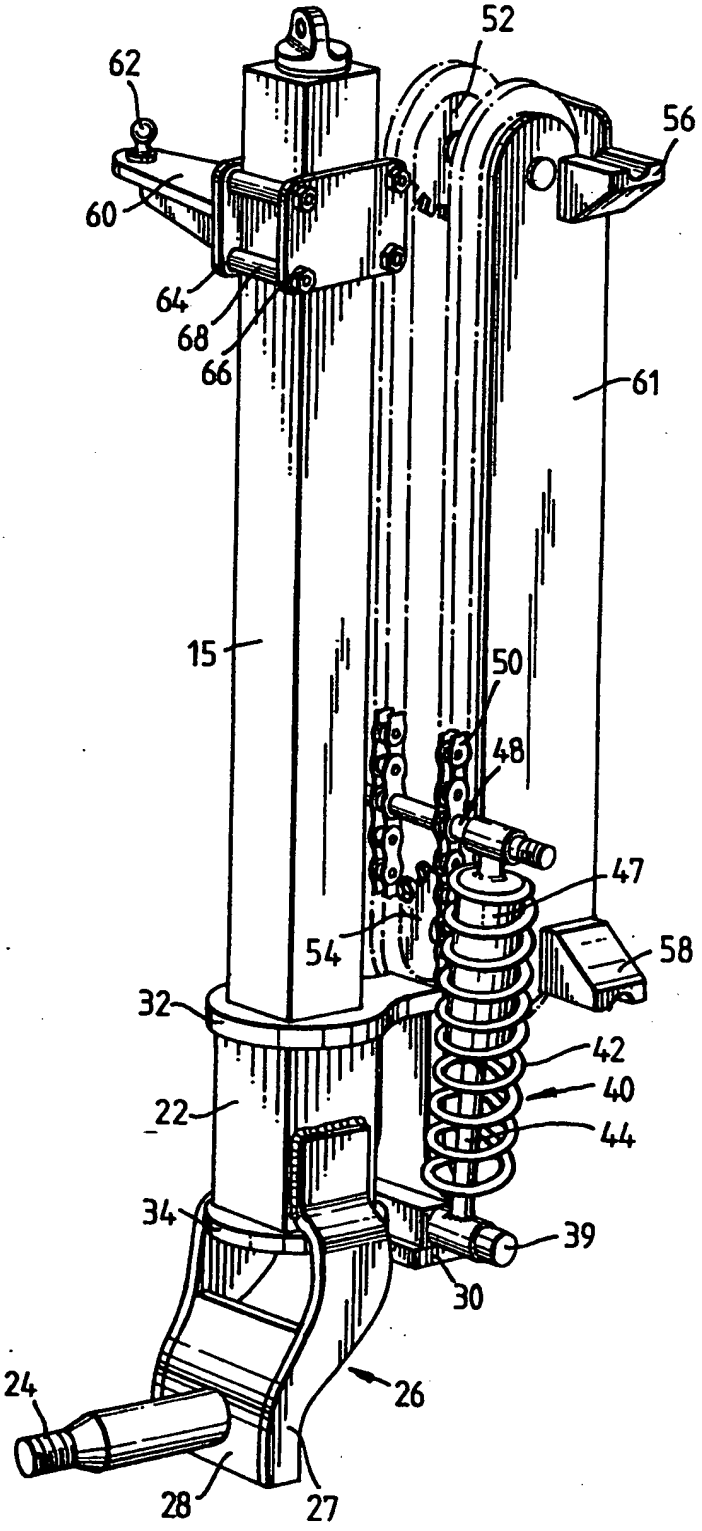
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FIG. 3

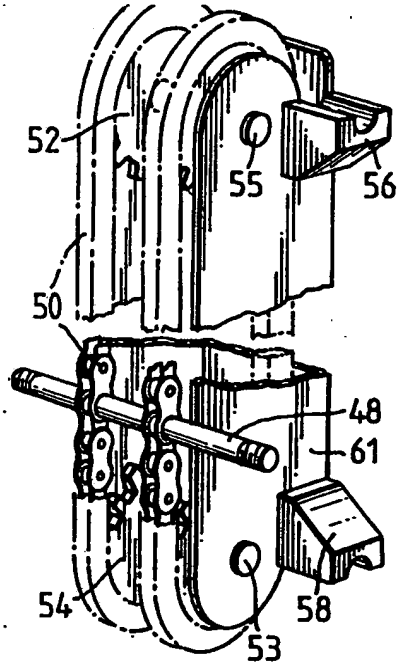
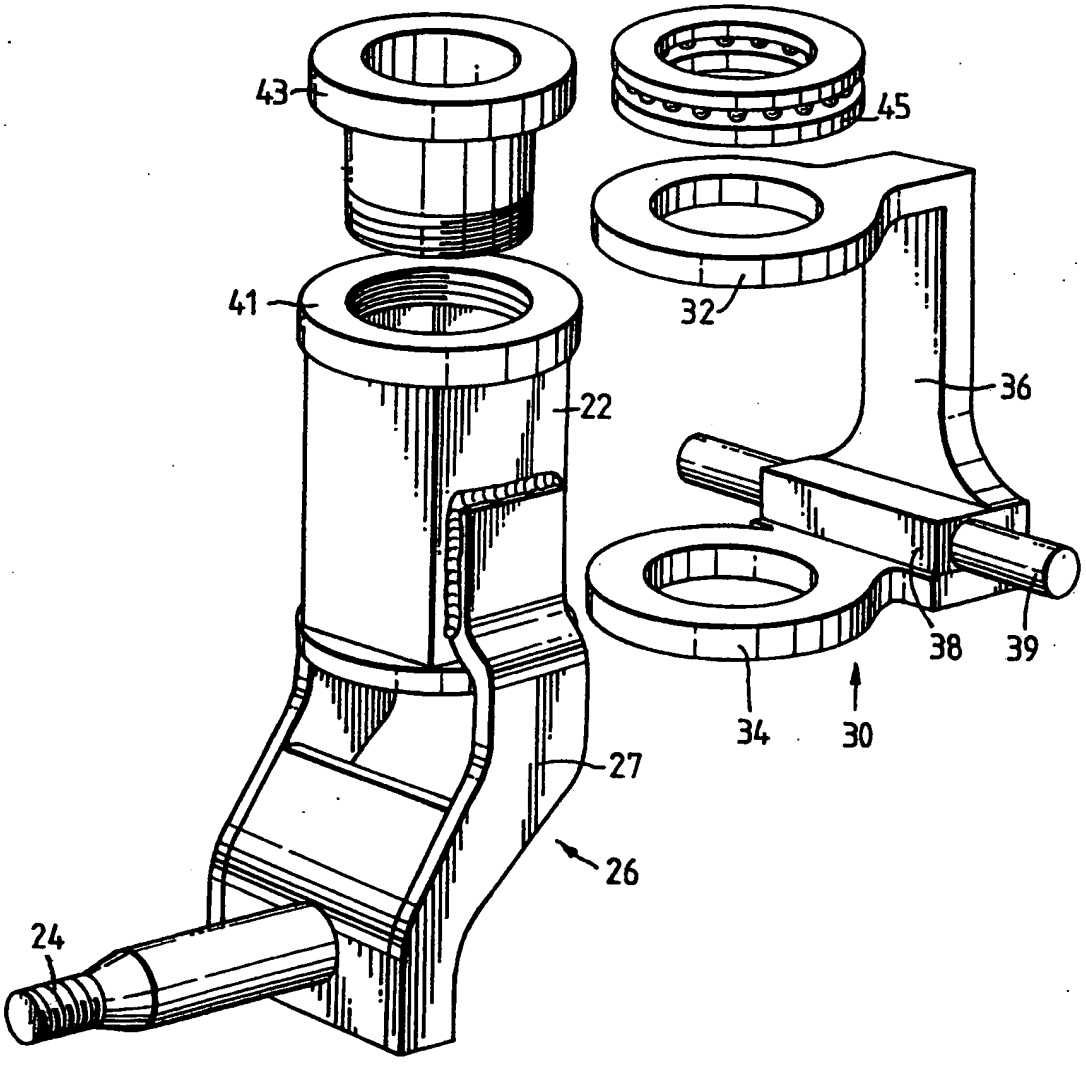


FIG. 4



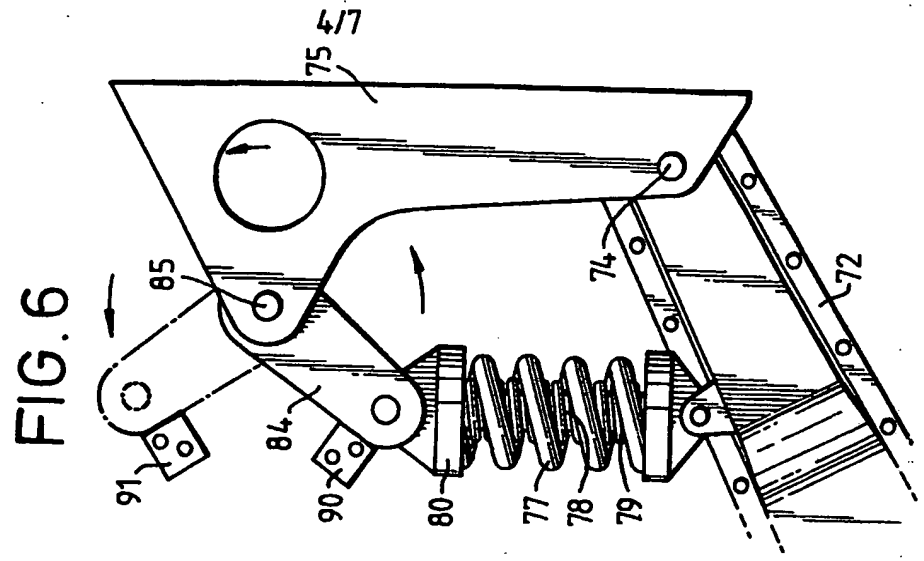

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FIG.6

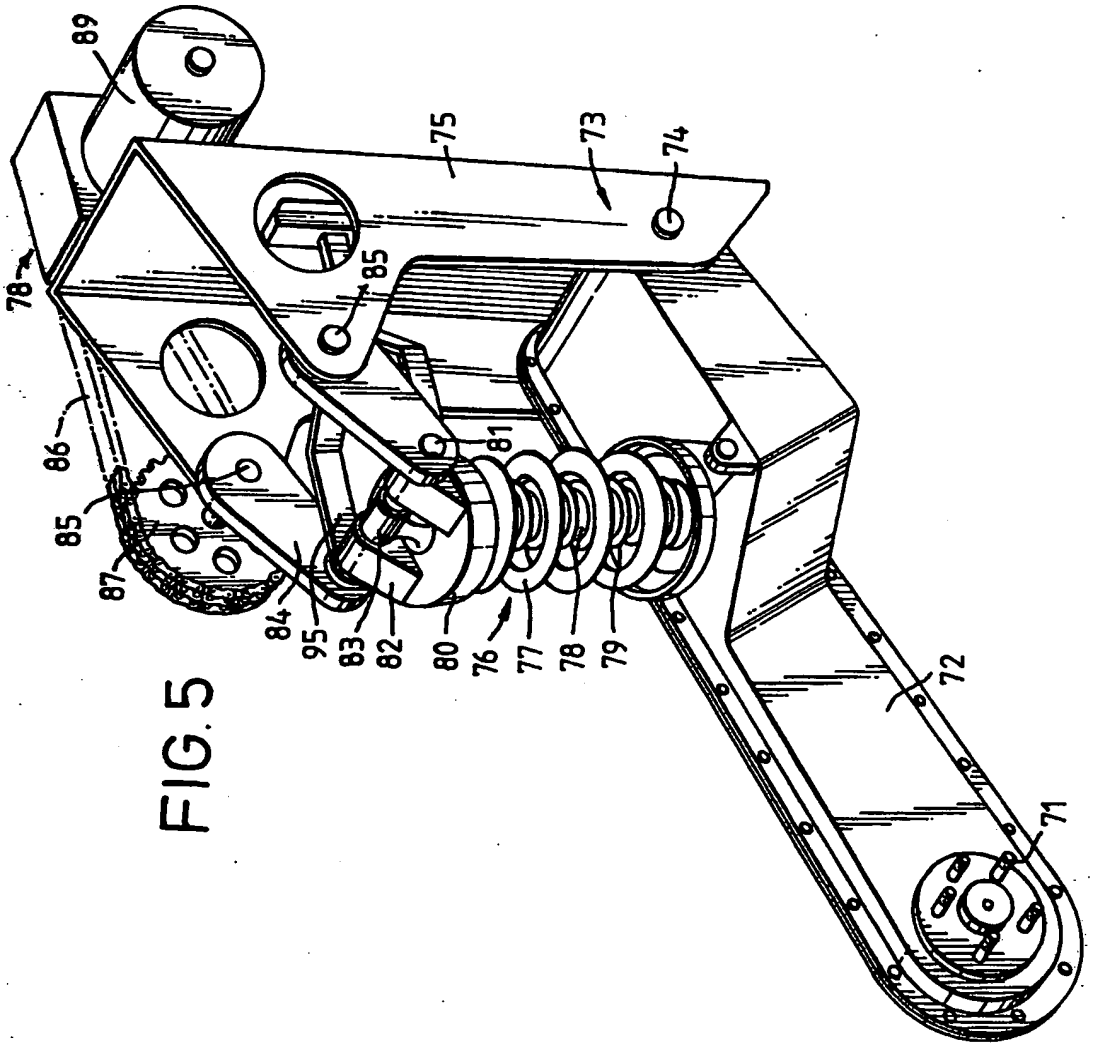
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FIG.5

FIG. 7

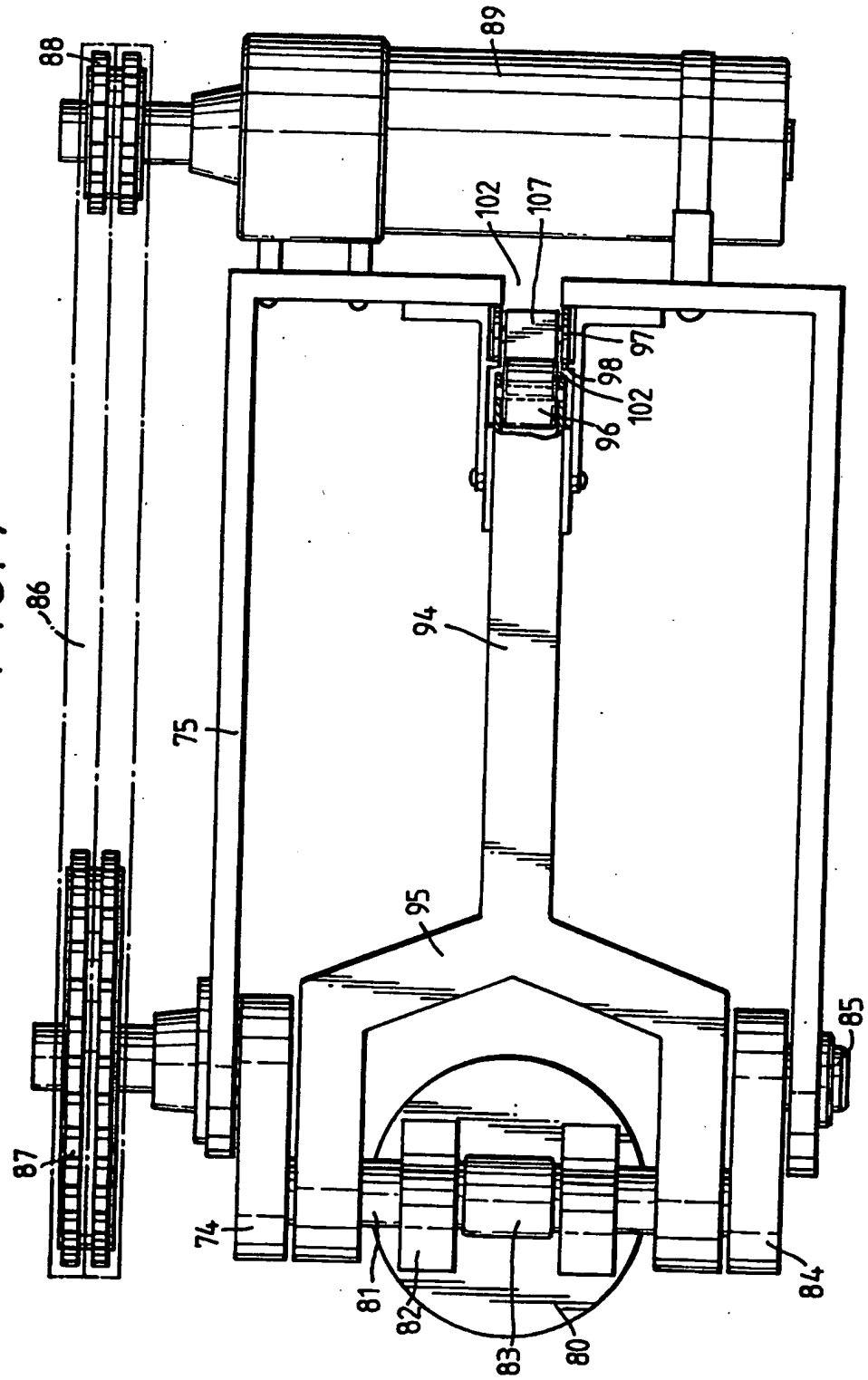


FIG. 8

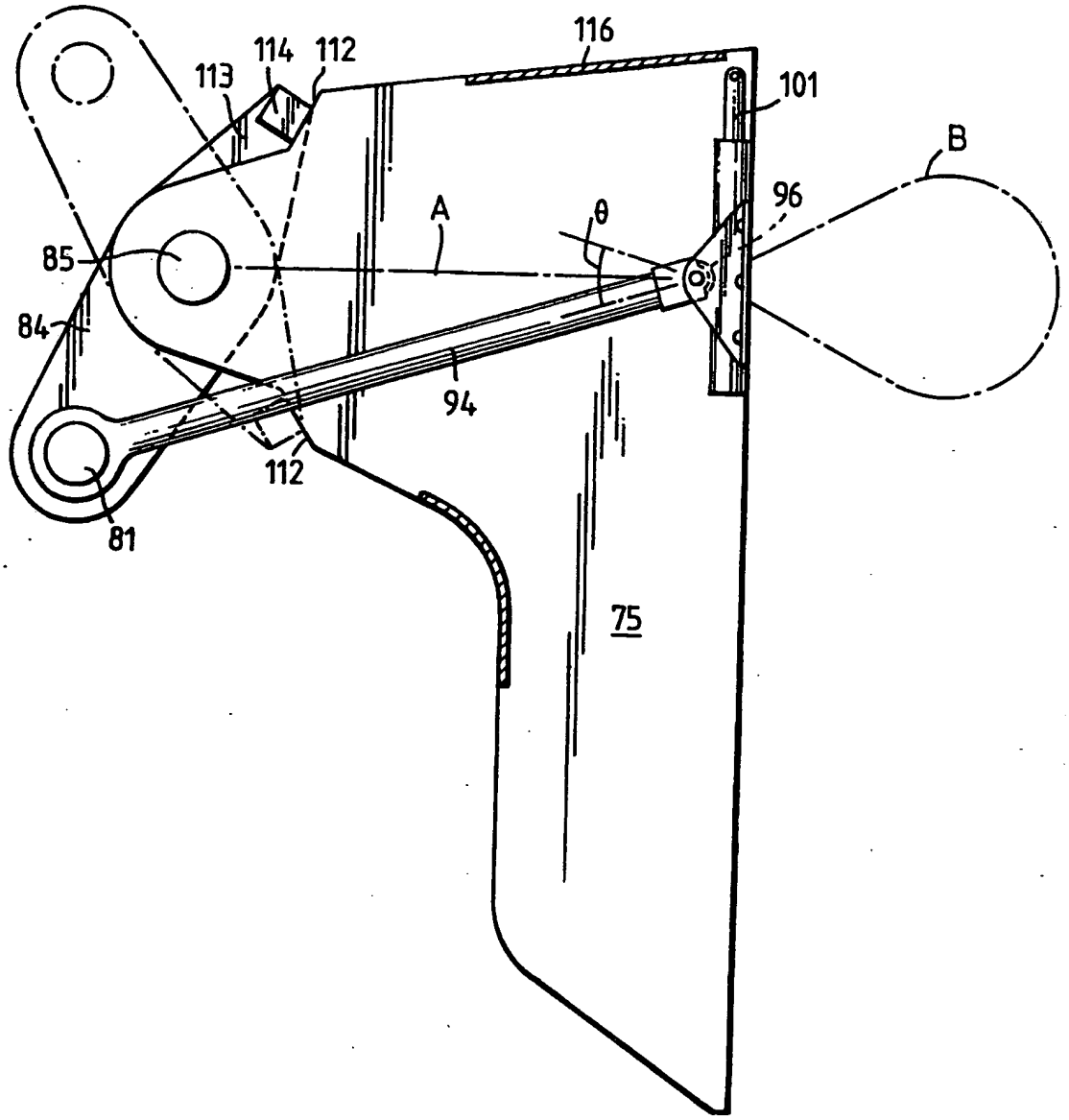


FIG. 8a

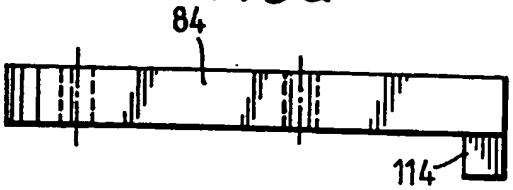
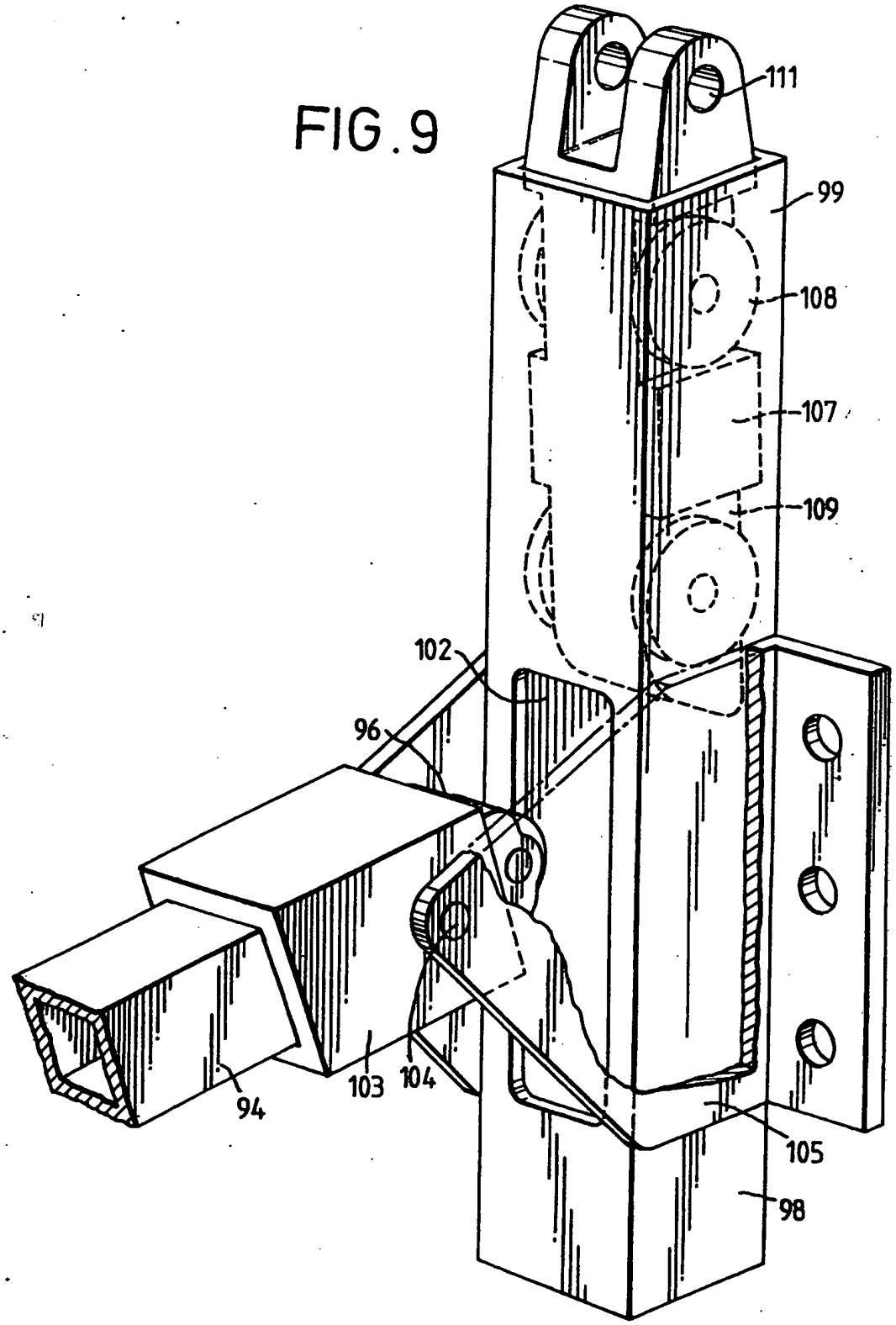


FIG.9



INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 93/00269

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 B60F3/00; B62D61/12

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	B60F ; B62D ; B63C

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No.[13]
X	US,A,3 227 123 (VOIGT) 4 January 1966 see column 6, line 3 - line 27; figures 11-14	1-3,6, 10-12
X	FR,A,2 568 215 (PAVON) 31 January 1986 see the whole document	1-3,10
A	US,A,3 653 332 (OLSON) 4 April 1972 see column 3, line 69 - column 4, line 44; figures	4-7
A	GB,A,2 134 052 (EISENWERKE KAISERSLAUTERN GOPPNER) 8 August 1984	

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° Special categories of cited documents : [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

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"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
26 MAY 1993	02. 06. 93
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	DE SCHEPPER H.P.H.

Form PCT/ISA/210 (second sheet) (January 1985)

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	US,A,3 421 472 (FRESNO) 14 January 1969	

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

GB 9300269
SA 70349

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A-3227123		None	
FR-A-2568215	31-01-86	None	
US-A-3653332	04-04-72	None	
GB-A-2134052	08-08-84	DE-A- 3302998	09-08-84
US-A-3421472	14-01-69	None	